REMARKS

Claims 1-11 were pending in the present application. By virtue of this response claim 1 has been amended without prejudice or disclaimer of any previously claimed subject matter and claim 12 has been added. Accordingly, claims 1-12 are currently under consideration. Support for the amendment to claim 1 and newly added claim 12 may be found throughout the present application, for example, page 8, lines 10-12 and page 18, lines 8-10. Amendment and cancellation of certain claims is not to be construed as a dedication to the public of any of the subject matter of the claims as previously presented.

I. Final Rejection

Initially, Applicants respectfully submit that the final Office Action mailed on November 1, 2002 (Paper No. 11) and the Supplemental final Office Action faxed on January 15, 2003 (Paper No. 12) are premature final Office Actions and the finality should be withdrawn. Specifically, the finality of the Office Actions are in clear error under MPEP § 706.07(a) because the rejection includes newly cited art against claims 1-6, which were not amended by the Applicant in response to the non-final Office Action mailed March 20, 2002. In particular, newly cited art Zauner et al. is now applied to claims 1-11 in combination with Kimura (U.S. Pat. No. 6,201,823) and Yuge et al. (U.S. Pat. No. 6,030,848). In the previous non-final Office Action of March 20, 2002, only Kimura was applied against claims 1-6. Therefore, because claims 1-6 were not amended by Applicant and the Examiner applied newly cited art in the final Office Action, the finality of the Office Action is premature under MPEP § 706.07(a) and should be withdrawn.

Further, the supplemental final Office Action was altered from referring to claims 8-11 to referring to claims 1-11 in response to an Interview with Applicant's Attorney on January 23, 2003, but the arguments in support thereof remained directed only to claims 8-11. Applicant's submit that there is no clear record of the statement of grounds for the rejection to claims 1-6 for

which the Applicant can readily respond and the supplemental final Office Action remains inadequate under MPEP § 706. Accordingly, a new non-final Office Action is requested fully and clearly stating the grounds for the rejection to claims 1-6.

II. Rejections under 35 U.S.C. §103(a)

Claims 1-11 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Kimura et al., U.S. Patent No. 6,201,823 (hereinafter "Kimura") in combination with Zauner et al. (hereinafter "Zauner") and Yuge et al., U.S. Patent No. 6,030,848 (hereinafter "Yuge").

A. Claims 1-7 and 12

Applicants submit that Kimura, Zauner, and Yuge, alone or in combination fail to disclose or suggest a nitride compound semiconductor light emitting device including, *inter alia*, "a GaN substrate having a crystal orientation which is tilted away from a <0001> direction by an angle which is equal to or greater than about 0.05 and which is equal to or less than about 2 … and wherein said active layer is formed evenly," as recited by amended claim 1. Newly added claim 12 discloses a similar nitride compound semiconductor light emitting device "wherein said acceptor doping layer is formed evenly."

Initially, Applicants note that the nitride semiconductor light-emitting device recited in claim 1 includes a GaN substrate having a crystal orientation that is slightly inclined within a range of 0.05° to 2° against a <0001> plane. This feature varies the growing condition of the nitride semiconductor provided on the GaN substrate, thereby reducing dislocation and aggregation of In disposed within the active layer for an increased smoothness. The smoothness of the active layer improves the quality of the active layer as well as the properties of the device. The p-type contact resistance can be reduced without particularly performing a p-type properties impairment process, thereby enabling efficient current injection, examples of which are

described on page 17, lines 5-11 of the present application. The incline of the surface of GaN substrate as claimed at the limited angle between 0.05° to 2° also provides improved results. For example, the claimed device has improved properties such as low resistance p-type contact, reduced threading dislocations, improved flatness, and improved emission characteristics, examples of which are described on page 18, lines 1-12 of the present application.

In contrast to claims 1 and 12, Kimura discloses a semiconductor device wherein a current block layer within a structure including a nitride semiconductor on a sapphire substrate is provided by selective growing at the time of forming the structure. The stripe marks are adopted to enable the selective growing of the current block layer. Kimura, col. 4, lines 39-47. With this arrangement of selective growing, however, at least one portion of the growing layer is formed with unevenness, and bends along the length of the selected growing layer. Therefore, the light emitting device as recited in claims 1 and 12 includes an active layer/acceptor doping layer "formed evenly," and is not disclosed or suggested by Kimura.

Further, Kimura discloses a device having a current block layer by means of selective growing, even where an angle of the substrate surface is largely tilted in the range of 0 to 10 degrees against the (0001)-face. Kimura, col. 6, lines 1-15. In light of this disclosure the purpose of tilting the substrate surface by a large angle of 0 to 10 degrees is apparently to form a current block layer, or the employment of selected growing thereof. Kimura also discloses an angle in a range of -5 degrees to +5 degrees to a [11-20] direction or a [1-100] direction, which is an angle to rotate the stripe marks within a plane of a substrate surface, but Kimura fails to disclose what direction an angle of the substrate surface is tilted against a (0001) plane thereof. Kimura, col. 6, lines 13-29.

In contrast, the recited devices of claims 1 and 12 improve the quality of an active layer itself by reducing In condensation and inversion within the active layer. This is upon changing the growth condition of a nitride semiconductor to be grown on the surface of a GaN substrate

which is slightly tilted in the extremely small range of 0.05 to 2 degrees against a (0001) plane. This provides the result that an active layer constituting an integral layer construction having a several nm period is formed evenly, to an extent less than an individual layer thickness of a well type layer and a barrier layer. Accordingly, the devices of claims 1 and 12 are markedly different from the disclosure of Kimura.

Further, the addition of Zauner and Yuge alone or in combination with Kimura fail to disclose or suggest the devices of claims 1 and 12 for at least the reasons that follow. In particular, Zauner fails to disclose or suggest a nitride compound semiconductor light emitting device including "a GaN substrate having a crystal orientation which is tilted away from a <0001> direction by an angle which is equal to or greater than about 0.05 and which is equal to or less than about 2 … and wherein said active layer is formed evenly," as recited by amended claim 1.

Zauner discloses an arrangement of homo-epitaxial growth on a single crystal GaN substrate, the epitaxial growth being conducted in a (0001) direction of the substrate surface. Within a GaN substrate having a polarity, a (0001) plane exists, which is the same as a Ga plane which is terminated with a Ga atom, and another (000-1) plane, which is the same as a N plane terminated with an N atom. The Ga plane substrate employed in the claimed device includes a homo-epitaxial growing of a mirror finished surface, and while it is well known that for the N plane substrate shown in Zauner, it is extremely different to provide growth of a mirror finished surface. In fact, table 1 of Zauner shows that a hillock density of 1,300 cm^{-2} remains, even in the case of tilting the surface plane to provide a convex and concave condition of large extent, which is difficult to compose with the growth on a Ga plane to be obtained in the claimed device. In contrast, the claimed device achieves a flatness having several nm, which is the same extent as a lattice constant. This is in addition to a substantial difference of plane direction of the substrate.

The addition of Yuge also fails to cure the deficiencies of Kimura and Zauner alone or in combination. In particular, Yuge fails to disclose or suggest "a GaN substrate having a crystal orientation which is tilted away from a <0001> direction by an angle which is equal to or greater than about 0.05 and which is equal to or less than about 2 ... and wherein said active layer is formed evenly," as recited by amended claim 1. Yuge merely discloses a method wherein a gas condition becomes nitrogen rich only after growing an active layer to eliminate the uppermost surface plane of the active layer from becoming rough until a p-type layer is grown after completing the growth of the bulk active layer. Yuge, col. 2, lines 48-63; col. 4, lines 48-63. Accordingly, Yuge fails to disclose a device wherein said active layer is formed evenly, let alone the recited orientation of the substrate, and the disclosure of Yuge is merely related to reducing the deterioration of an active layer after completing the growth of a bulk active layer. Therefore, Yuge alone or in combination with Kimura and Zauner fails to disclose or suggest the nitride compound semiconductor light emitting device as recited in claims 1 and 12. Further, nothing within the disclosure of Yuge provides any teaching, motivation, or suggestion for the combination with Kimura and Zauner.

Therefore, in light of the above remarks and amendments, the applied references fail to disclose or suggest all of the elements of the semiconductor device of claims 1-7 and 12. Further, there is no teaching, suggestion, or motivation to combine the references to meet the limitations of claims 1-7 and 12. Accordingly, claims 1-7 and 12 are allowable over Kimura, Zauner, and Yuge alone or in combination and the rejection should be withdrawn.

B. Claims 8-11

With regard to claims 8-11, Applicants submit that that Kimura, Zauner, and Yuge whether alone or in combination fail to disclose or suggest a method for producing a nitride compound semiconductor light emitting device including, *inter alia*, "a semiconductor multilayer

structure including an active layer of a quantum well structure made by a nitride compound semiconductor and an acceptor doping layer is integrated on a GaN substrate having a crystal orientation which is tilted away from a <0001> direction by an angle which is equal to or greater than about 0.05° and which is equal to or less than about 2°, the active layer including at least one barrier layer and at least one well layer," as recited by claim 8.

Kimura discloses a method of production including forming a current block layer by means of selective growing, even where an angle of the substrate surface is largely tilted in the range of 0 to 10 degrees against the (0001)-face. Kimura, col. 6, lines 1-15. In light of this disclosure, it is apparent that the purpose of tilting the substrate surface by a large angle of 0 to 10 degrees is to form a current block layer, or the employment of selected growing thereof. Kimura also discloses an angle in a range of -5 degrees to +5 degrees to a [11-20] direction or a [1-100] direction, is an angle to rotate the stripe marks within a plane of a substrate surface, but Kimura does not mention the limitation of what direction an angle of the substrate surface is tilted against a (0001) plane thereof.

In contrast, the method of claim 8 improves the quality of an active layer itself by, for example, reducing In condensation and inversion within the active layer. This is achieved upon changing the growth condition of a nitride semiconductor to be grown on the surface of a GaN substrate which is slightly tilted in the small range of 0.05 to 2 degrees against a (0001) plane. This provides the result that an active layer constituting an integral layer construction having a several nm period is formed evenly, to an extent less than an individual layer thickness of a well type layer and a barrier layer. Accordingly, the method of claim 8 is markedly different from the disclosure of Kimura.

Further, the addition of Zauner and Yuge alone or in combination with Kimura fail to disclose or suggest the method of claim 8 for the reasons that follow. In particular, Zauner fails to disclose or suggest a method for producing a nitride compound semiconductor light emitting

device including "a semiconductor multilayer structure including an active layer of a quantum well structure made by a nitride compound semiconductor and an acceptor doping layer is integrated on a GaN substrate having a crystal orientation which is tilted away from a <0001> direction by an angle which is equal to or greater than about 0.05° and which is equal to or less than about 2°, the active layer including at least one barrier layer and at least one well layer," as recited by claim 8

Zauner discloses an arrangement of homo-epitaxial growth, on employing a single crystal GaN substrate, the epitaxial growth being conducted in a (0001) direction of the substrate surface. Within a GaN substrate having a polarity, a (0001) plane exists, which is the same as a Ga plane which is terminated with a Ga atom, and another (000-1) plane, which is the same as a N plane terminated with a N atom, and it is possible to select either one of the Ga plane and N plane by working. The Ga plane substrate of claim 8 includes a homo-epitaxial growing of a mirror finished surface, while it is well known that for the N plane substrate shown in Zauner, it is extremely different to provide growth of a mirror finished surface. In fact, table 1 of Zauner shows that a hillock density of 1,300 cm^{-2} remain, even in the case of tilting the surface plane to provide a convex and concave condition of large extent, which is difficult to compose with the growth on a Ga plane to be obtained in the claimed method. In contrast, the claimed method may achieve a flatness having several nm, which is the same extent as a lattice constant. This is in addition to a substantial difference of plane direction of the substrate.

The addition of Yuge also fails to cure the deficiencies of Kimura and Zauner alone or in combination. In particular, Yuge also fails to disclose or suggest a method for producing a nitride compound semiconductor light emitting device including "a semiconductor multilayer structure including an active layer of a quantum well structure made by a nitride compound semiconductor and an acceptor doping layer is integrated on a GaN substrate having a crystal orientation which is tilted away from a <0001> direction by an angle which is equal to or greater

than about 0.05° and which is equal to or less than about 2°, the active layer including at least one barrier layer and at least one well layer," or "stopping the growth of the active layer for a certain period of time after forming the well layer of the active layer including the at least one barrier layer and at least one well layer," as recited by claim 8.

Yuge merely discloses a method wherein a gas condition becomes nitrogen rich only after growing an active layer, in order to eliminate the uppermost surface plane of the active layer from becoming rough until a p-type layer is grown, after completing the growth of the bulk active layer. Accordingly, Yuge fails to disclose a practical method of growing an active layer with the recited orientations, and the object of Yuge is merely related to reduce the deterioration of an active layer after completing the growth of a bulk active layer. In contrast, the method recited in claim 8 includes an arrangement of a quantum-well type active layer including at least one well-type layer and a barrier layer, but not a bulk active layer. There is thus a clear difference in method and construction between the active layer recited in claim 8 and Yuge.

Furthermore, the heat treatment in Yuge is only applied after completing the growth of a bulk active layer. Interrupting growth as recited in claim 8 is aimed at gradually promoting the quality of a well-type layer and a barrier layer individually, upon stopping the supply of III group materials after forming the well-type layer and barrier layer while growing the multiple quantum well type active layer. In Yuge, the heat treatment is conducted at a time after growth of the bulk active layer, and then it moves to the growth of p-type layer. The method of claim 8, however, relates to a technique of interrupting the growth repeatedly during growth of the active layer, and not the growth of a p-type layer after the repeated interrupted growth. Accordingly, there is a clear difference between Yuge and the method of claim 8, which is not cured by Kimura or Zauner.

Therefore, in light of the above remarks and amendments, the applied references fail to disclose or suggest all of the elements of the present invention. Accordingly, claims 8-11 are

allowable over Kimura, Zauner, and Yuge alone or in combination and the rejection should be withdrawn.

CONCLUSION

Applicant has, by way of the amendments and remarks presented herein, made a sincere effort to overcome rejections and address all issues that were raised in the outstanding Office Action. Accordingly, reconsideration and allowance of the pending claims are respectfully requested. If it is determined that a telephone conversation would expedite the prosecution of this application, the Examiner is invited to telephone the undersigned at the number given below.

In the unlikely event that the transmittal letter is separated from this document and the Patent Office determines that an extension and/or other relief is required, applicant petitions for any required relief including extensions of time and authorizes the Assistant Commissioner to charge the cost of such petitions and/or other fees due in connection with the filing of this document to **Deposit Account No. 03-1952** referencing docket no. 299002051800. However, the Assistant Commissioner is not authorized to charge the cost of the issue fee to the Deposit Account.

Respectfully submitted,

Dated: May 15, 2003

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